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ABSTRACT

This paper describes a program implemented by Tennessee Technological University that provided a science enrichment program for disadvantaged and minority high school feamles in the rural areas surrounding the university and from inner city schools of Nashville, Knoxville, and Chattanooga. This model is based on a similar program that was successful in encouraging scientific interest among disadvantaged females and minorities in gades 7-11. The science enrichment program consists of 3 weekends and a 10-day summer workshop for approximately 25 high school females. Participants are recommended by teachers or counselors as having academic potential in science but having obstacles to postsecondary study in science. Participants receive instruction in biology, physics, chemistry, mathematics and computer applications. All classes are laboratory centered with hands-on activities. The program also includes discussion on successful female role models, field trips, interaction with scientists and university students and faculty, and experience of campus life. At the close of the two previous summer sessions, a 20-item test of science understanding was administered to the participants. The scores were encouraging when compared to the national mean scores of 17 year olds. Pre- and post-workshop tests measuring attitudes toward science and self-image indicate positive changes. Written evaluations from participants were positive. Recommendations for implementing a similar program are included. (LP)

NRSSC PRESENTATION
Presenter: Robert Swindell
Co-Presenter: Margaret Phelps
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Designing and Implementing Science Enrichment Programs for Rural Females

DESIGNING AND IMPLEMENTING SCIENCE ENRICHMENT PROGRAMS FOR RURAL FEMALES

A Paper

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by

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DESIGNING AND IMPLEMENTING SCIENCE ENRICHMENT PROGRAMS FOR RURAL FEMALES

Introduction

A significant shortage of physical scientists, engineers, and math and computer scientists in the United States has been predicted for the next decade. This gloomy forecast is based on several factors. (Vetter, 1988) First, the traditional pool of white mostly male students which was the source of most of these scientists is expected to show a significant decrease over the next ten years. Additionally the number of American science and engineering majors (S/E) continuing on to obtain PhD degrees has shown a significant drop in recent years.

This is true even though the number of degrees in the physical science and engineering has actually increased since 1980. This increase is attributed primarily to a the increase in the number of doctorates awarded to foreign citizens in the physical and mathematical sciences and engineering. By 1986 nearly one third of of the doctorates awarded in U. S. Universities in math and physical sciences and more than half in engineering were awarded to foreign nationals.

While it is true that many of these doctoral recipients will remain here and become a part of the work force, it is important to realise that potential or actual problems may be associated with too great a reliance on this talent pool. In the future we may not be able to count on these best and brightest individuals to remain in the U.S.A. Their home countries may induce or force them to return in order to stem the "brain drain" from these countries. Furthermore, the utilization of these foreign nationals as teaching assistants and/or professors in our universities can also result in problems. Communication problems associated with language barriers can adversley affect both male and female students. Likewise cultural backgrounds of some foreign students may be at odds with the American view that women are fully capable of pursuing careers in science and engineering. Recent data indicates that there is an increasing incidence of women dropping out of engineering before completing a bachelors degree. This in spite of the fact that women who choose engineering as freshmen

are already more highly filtered than their male counterparts, have had higher SAT math scores and typically stay in the top third of their class. Some of this attrition has been attributed to the negative effect of foreign teachers and teaching assistants on undergraduate women.

Additional problems arise from the tendency of new PhD.s in S/E to take industial jobs rather than choose careers in academe. One consequence of this is that the average age of the faculty in the sciences has increased significantly during the past decade due to the lack of new hires.

These concerns must be addressed if the United States is to retain its premier position in scientific achievement in tomorrows world. Since the demographics suggest that the traditional pool of American scientists, white Anglo-Saxon males, is slowly decreasing, it is apparent that we must look elsewhere for replacements for our scientists and engineers. Two major relatively untapped pools of talent that are available include females and minorities.

As recently as 1985 the percentage of female PhD engineers was 2% and in the physical and math sciences less than 8%. Minorities make up only 2% of the PhD.s in engineering, math and sciences. It is projected that by the year 2020 almost half of the American school age children will be identified as black, Hispanic, Asian American, or American Indian. Presumbaly approximately half of all the American population will also be female. It is from these pool that many of our future scientific replacements must come.

Background

In an effort to address these concerns and problems a joint project involving the Department of Chemistry in the College of Arts and Sciences and the Department of Curriculum and Instruction in the College of Education at Tennessee Technological University was undertaken beginning in 1988. This project targeted students in the 9th - 11th grades and focused on involving disadvantaged female, minority and handicapped students from the rural areas surrounding Tennessee Technological University and from inner city schools of Nashville, Knoxville and Chattanooga. A primary objective of the project was to promote interest and

development in science of these young students.

The format of the project was derived from experiences obtained from involvement in previous workshops conducted in Clay County Tennessee during the summers of 1986-87. (Scott, 1986) All participants were volunteers who were interested in science and were willing to devote a minimum of 4 hours of time each Saturday for a period of 6-8 weeks. Approximately thirty students participated in the program each summer. In addition to these students 4-6 classroom teachers from the Clay Co. school system were present for each session. The program began in as a cooperative effort between the Clay County Schools and the TTU Department of Chemistry. This program was designed to increase scientific interest among disadvantaged females and minorities, grades 7-11, in science. Activities for this project included short, intensive instructional periods utilizing computer assisted instruction, audio-visual aids and extensive hands-on laboratory experiences designed to relate scientific principles to real-world situations. Additionally, interactions with role-model scientists and visits to nearby industrial, governmental and private scientific and research facilities were conducted in order to increase scientific career awareness.

Since the student's knowledge and understanding of any given science concept was expected to be, at best, marginal it was imperative that explicit and detailed explanations of the scientific principles, procedures, and most importantly, safety considerations appropriate to each laboratory session be given prior to entering the laboratory. To accomplish this each student was provided with appropriate printed explanatory material relevant to each exercise or experiment to be performed. Prior to the beginning of each session, discussion of the topic to be considered was made by one of the University faculty participants to the participants. Extensive use was made of demonstrations, audio-visual aids, and computer assisted learning. Sufficient time for questions and clarification was allotted at each session.

A selected series of laboratory experiments was performed by each participant. These experiments were carefully chosen in terms of appropriateness to the topic, effectiveness for learning, safety, potential for increasing

interest, availability for future use at participants schools and simplicity. The format of the sessions was designed to expose the students to some interesting and enjoyable aspects of science. To accomplish this Chemistry Professors from Tennessee Technological University in Cookeville TN. used a variety of chemical demonstrations and supervised hands-on laboratory experiments in which each student participated. The general format included preliminary discussion and demonstrations of chemical or physical phenomena and explanations of the day's experiments. Students were divided into small groups and assigned to work stations. Each group of students was supervised by class-room teachers from Clay Co. while over-all supervision of the experiments was done by the University chemistry professors. After completion of the experiments the participants discussed the principles demonstrated in the laboratory. Following the completion of each laboratory session a period for evaluation and discussion of results was held in which all faculty and students participated.

During the project opportunity for each student participant to meet and discuss items of interest with successful female role models was presented. Interactions included both group and individual sessions. Scientists were selected from private industry, academic and governmental sectors and were carefully chosen for their interest and ability to interact with the junior high age group. Examples included female and/or minority research scientists, physicians and other medically related professionals as well as successful professionals in vocations closely, but not directly related to traditional science careers, but requiring an appreciable amount of scientific training or knowledge.

Conclusions. Student interest was maintained at a high level throughout the program. An increased interest in science was evidenced by both verbal and written responses to evaluation instruments (Figure 1). Evaluation of student responses to self-image questions indicated a trend toward a more positive attitude toward self (Figure 2). Classroom teachers gave positive comments and indicated interest in incorporating some of the experiments into their own classroom activities.

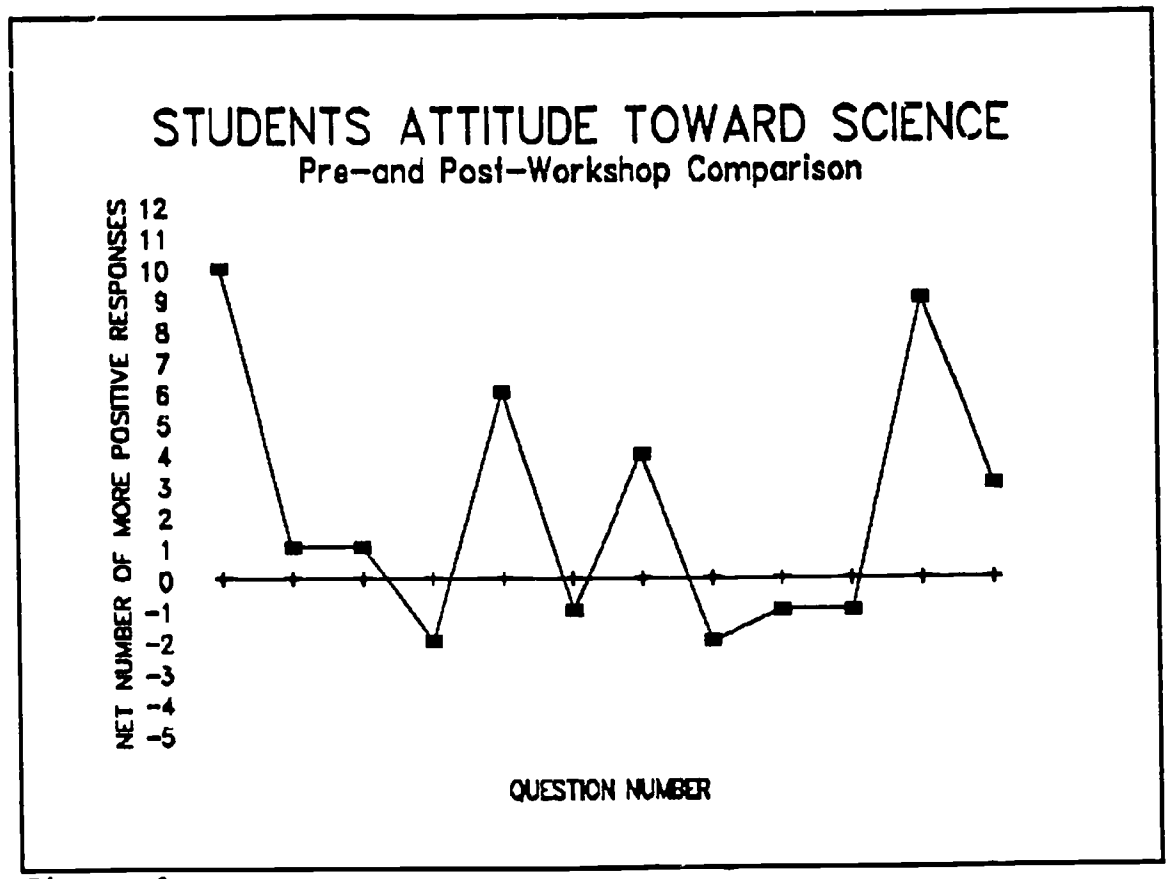

Figure 1.

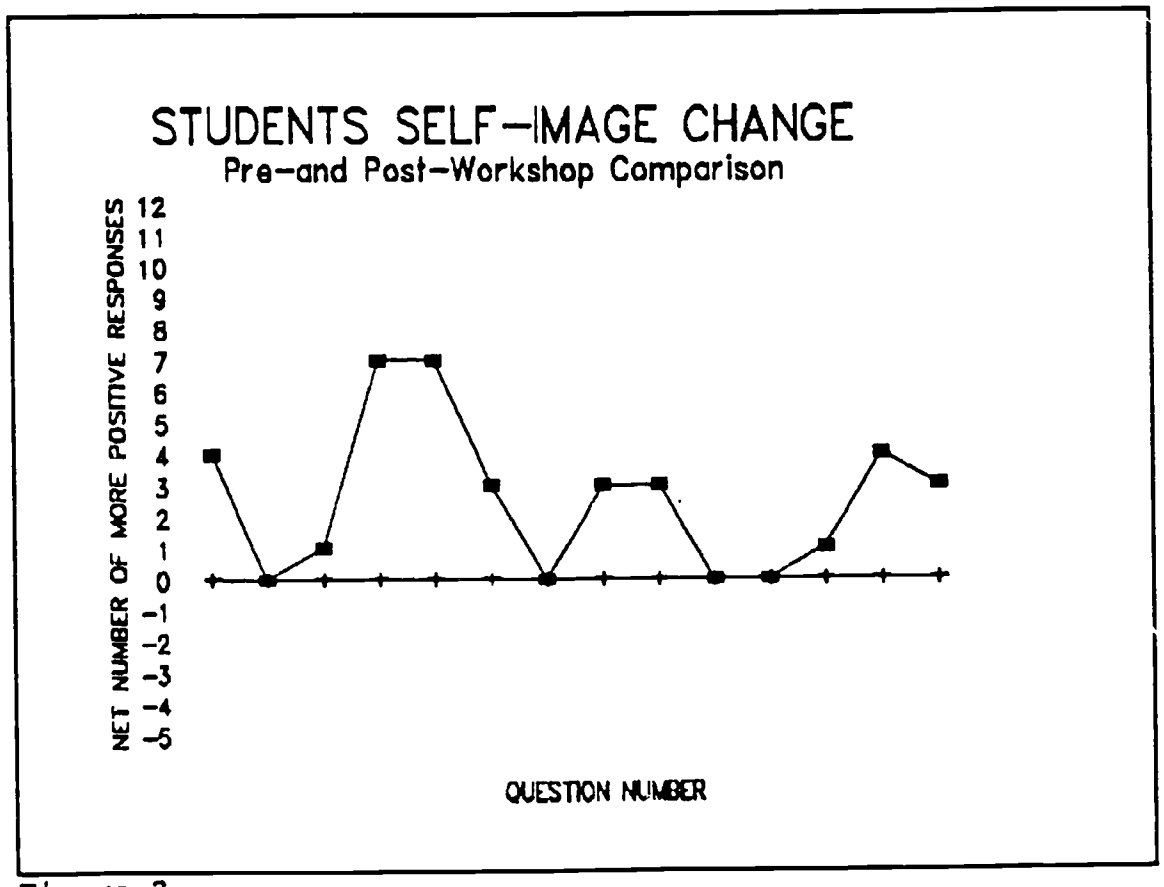

Figure 2

Expanding Disadvantaged Student Access to Science Enrichment Programs.

In an effort to expand the type of programming provided in the Clay County project to a wider audience, TTU applied to the Tennessee Department of Vocational Education for funding to initiate a science enrichment program for disadvantaged and minority females. Now in its third year, this program consists of three weekends and a ten-day summer program for approximately twenty-five high school females, primarily from rural high schools in economically disadvantaged communities. A small number of minority students from urban schools also participate. The program includes formal instruction in biology, physics, chemistry, mathematics, and computer applications. All classes are laboratory centered with maximum hands-on activities. Other components include female role models, exploration of the arts, field trips, interaction with university students and faculty, personal development, and campus life. The schedule for the most recent weekend is presented in Figure 3.

Figure 3

TYPICAL WEEKEND SCHEDULE

Friday, January 25

5:00	Registration on TTU Campus
5:30	Pizza Dinner, Get Acquainted, Program Overview (Staff present)
6:30	Computer Applications on the MacIntosh
8:30	Depart for Appalachian Center for Crafts
9:30	Recreation directed by Counselors

Saturday, January 26

7:00	Breakfast at Craft Center
7:45	Depart for TTU Main Campus
8:30	Chemistry/Physics Laboratory (electroplating,
11:45	Buffet Lunch
1:00	Mathematics (Solving word problems)
2:15	Biology Laboratory (Dissection of sharks and fetal chickens)
4:30	Self-defense for females
6:00	Dinner
7:00	Depart for Cookeville Drama Center (Steele Magnolias)
10:00	Depart for Craft Center

Sunday, January 27

7:30	Breakfast
8:15	Depart for TTU Main Campus
9:30	Research Design
11:30	Buffet Lunch
12:30	Wrap-up and Evaluation
1:00	Depart for Home

The staff for the program includes:

Director--Director of Rural Education
Co-Director--Chair of Chemistry Department
Program Director--Faculty Member in Gifted Education
Program Secretary--Rural Education Secretary
Program Facilitator in Charge of Arrangements--C&I Secretary
Chemistry/Physics Instructor--Faculty Member in Chemistry
Biology Instructor--High School Biology Teacher
Mathematics Instructor--Faculty Member in Remedial Studies
Computer Instructor--Public School Special Education Teacher
Counselors--A married couple and 2 female college students

Classes are held on the main campus with field trips (primarily in the summer) within 100 miles. Housing is provided wherever space is available on the main campus or other University facilities. One weekend the students stay at a State Park and most of the classes are conducted there. Transportation during the program is provided in University vans with the counselors and/or instructors doing the driving. Meals are provided in the University cafeteria or are prepared by the staff. The only costs to participants are transporation to and from the program and incidental spending money.

On the weekend for which the schedule is presented there were twenty girls who attended representing twelve high schools in ten school systems. They included two Blacks, one Oriental, and seventeen Caucasians. Each had been selected by a high school teacher or counselor as having academic potential in science but having some hinderance to post-secondary study in science. Some were from high schools with limited offerings, some were from families who do not encourage advanced study, most were from economically disadvantaged homes, and one was an international student. For some of the students this was their first participation in the program; others are nearing the end of their third year of participation. Once selected, students may remain in the program through the summer they graduate from high school. The "old" girls assist the "new" girls in getting acquainted, finding classrooms, and becoming a part of the program.

Evaluation Results. At the close of each of the two previous summer sessions, a 20 item Test of Science Understanding was administered to the participants. The mean results for each group and a national sample of 17 year olds are provided in Table 1. Considering that our group consists of disadvantaged and minority females, their comparative scores are encouraging.

Table 1

Science Understanding by Categories

Area	Summer 1989	Summer 1990	17 Yr Olds
Everyday Science Facts	95.6%	93.8%	99.9%
Understand Simple Scientific Principles	95.6%	96.3%	96.7%
Apply Basic Scientific Information	84.4%	71.3%	80.8%
Integrate Specialized Scientific Information	60.0%	45.0%	70.5%

Each group also was administered an Attitude Toward Science instrument. Mean responses ranged from 3.7 to 4.6 on a 5.0 scale on items positive towards science. In addition a questionnaire was administered in which the participants were asked to identify which of 25 jobs could be best filled by women, men, or either. The subjects appeared to rate positions that required advanced formal study as being suitable for either sex. Some traditional positions (such as farmer and cheerleader) were noted as best for a particular sex. Science careers were felt to be appropriate for either sex.

At the end of each session, the participants are asked to write an evaluation of the program. They give candid reactions to all activities and to the staff. Except for minor suggestions which we are usually able to implement or facilities problems beyond our control, reactions are highly positive. It is particularly rewarding to see "our girls" on campus as freshmen, confident and successful in their chosen majors.

Recommendations

For anyone interested in starting a program similar to this one, we would offer the following suggestions--in no particlar order.

Funding. If one is going to serve disadvantaged and/or minority students, external funding is critical. Possible sources include scientific industries, museums, foundations, or Carl Perkins Act funds. If students have to pay their own way, the program will serve primarily affluent students. Such programs on our campus are called "Gifted, Talented, and RICH".

Staffing. The leadership must be knowledgeable of program objectives and dedicated to achieving them. It is reasonable for the University to contribute

some administrative costs (in the name of good will and recruitment) while the program provides some extra pay for the leadership. Personnel funds should be primarily directed toward the instructors, support staff and counselors. Instructors should like young people, be interesting teachers, and be highly knowledgeable of their content areas. We prefer females who can serve as role models as well as instructors although two of our best instructors are men who teach in area schools. The more "hands-on" the classes, the better they are liked. We attempt to keep the core staff of instructors and counselors as long as possible while varying the role models and enrichment people. For counselors we use mature college students in science or education. Having a married couple provides for additional security when the students are housed off-campus. The counselors sleep and eat with the girls, coordinate recreation activities, and get them from place to place.

Student Recruitment. At first letters were sent to a science teacher in each of the high schools in the service region and to the science supervisors in Knoxville, Nashville, and Chattanooga. From this we have developed a group of teachers and counselors who understand the goals of the program and who refer students to us. We began attempting to include two girls from each high school participating. Now we serve one to four from a single school. Participants sometimes recruit friends for the program. Program publicity has resulting in more requests that we are able to accommodate. We keep a school's students in the program

Facilities. University dormitories on the main campus are the easiest to use because they are inexpensive and no transporation is needed. On our campus, dormitories are only available in the summer. State parks are great if you can have a lodge in which you can house, feed, and instruct students. Classes should be held in the setting where those college classes are held. The girls loved using the new Mac Lab which was only opened a few days before they came to campus. In Chemistry and Biology, they use the same lab, equipment, and supplies as the college students.

Meals. Friday night pizza has become a tradition. (The girls like plain cheese or cheese and pepperoni only!!!) When weather permits we do picnics or cookouts. Breakfast is usually cereal, fruit, juice, milk, and rolls served

informally where they sleep. The girls prefer meals we prepare (that includes Kentucky Fried Chicken) to eating in the cafeteria. They eat more for less when we do it ourselves. Doing so requires a staff person who is willing to shop, prepare, serve, and clean-up.

Field Trips. Field trips have included Oak Ridge National Laboratories, NASA Space Center at Huntsville, and a horse breeding farm in Shelbyville owned and operated by a woman. Each of these was done during the longer summer program. The spring session is held at Standing Stone State Park with ecology field and stream excurions within the park.

Enrichment. We like to include a wide variety of activities including plays, a trip to the Cookeville Mall each summer, art instruction, sing and dance-a-longs, self-defense, college basketball and football games, putt-putt golf, volleyball, Boys State Governor's Ball, swimming, games, demonstrations by artists at the Appalachian Center for Crafts, and whatever activity is available at a reasonable (or no) price.

Role Models. Each female that works with the program shares her personal and professional experiences with the students. Through this the girls become aware how decisions about marriage, family, and career are reflected in lifestyle and that there are many options available to them.

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